INTERNATIONAL SYMPOSIUM
ON
COMPOST RECYCLING OF WASTES

Athens, Greece
4-7 October 1989

Convener & Editor
C. Balis

Commission Plant Substrates
Working Group Composting of Waste Materials

THE USE OF ORGANIC WASTE MATERIALS AS ORGANIC FERTILIZERS - RECYCLING OF PLANT NUTRIENTS

Ruzena Gajdos
Department of Horticultural Science
Swedish University of Agricultural Sciences
Box 55, S - 230 53 Alnarp

Abstract
The present paper reviews principles for composting, further bioassay on the quality of different composts by plant reaction and finally nitrogen changes during "short-time" composting in containers with and without insulation.

Introduction
COMPOST is the product created by the biological decomposition of organic matter under controlled conditions (Golueke, 1972). It is important to understand the principles behind composting in order to apply them in the most efficient manner (Poincelot, 1974). Organic matter contains an extensive population of indigenous bacteria (ca 5 000/mm) and fungi (o hyphae ca 7-8 000/mm) (Ljunggren, 1989). These microorganisms require carbon for energy and growth, nitrogen for protein synthesis. When the carbon/nitrogen ratio, level of other nutrients, moisture and oxygen levels are favourable (Fig. 1), microorganisms will grow and start the process of aerobic decomposition. The temperature in the compost begins to increase from heat generated by biological oxidations. When the level of available energy decreases, decomposition slows down and the material cools off. Because of water losses, moisture content decreases during composting. The pH is initially acidic, but later becomes alkaline due to ammonia formation. Finally, pH becomes neutral or slightly alkaline. Grinding greatly accelerates the composting rate, increasing the surface area, which results in greater susceptibility and increased availability of oxygen. Users of compost find that a shredded or ground material can be applied more readily and uniformly to the land (Gotaas, 1956).

The suitability of composted material to be part of a growing media (to substrates and soils) is often described as compost maturity. Nevertheless, in the end of any composting is the need to get product fit for growth. "No method could be offered other than an empirical one for testing compatibility between growing medium and cultivar" (Acorck and Overcash, 1983).

The main aim of my work is to help to solve pollution problems and save energy by recycling organic waste. We have no other alternatives than to utilize wastes as resources. Is it still cheaper to burn or dump our organic wastes? Here I will present a series of experiments done at Alnarp in Sweden.

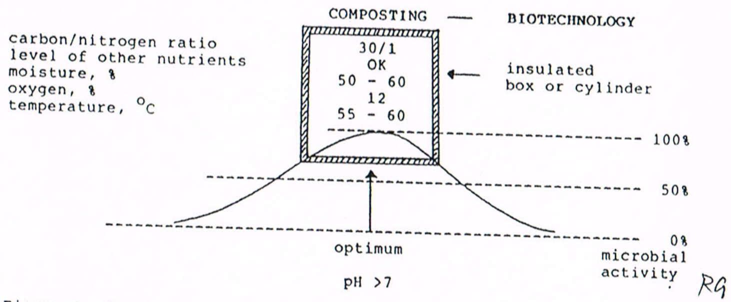

Figure 1. The optimal conditions for producing compost (according to Gotaas, 1956; Parr and Willson, 1980; Poincelot, 1974; Ljunggren, 1989).

I want to emphasize that in order to get optimum biological activity it is important to use the right technology (Fig. 1). The best product can only be created with technology which respects biological laws, i.e. BIOTECHNOLOGY.

Composting can be compared with human digestion, consisting of three parts (Fig. 1). **Pre-processing** - grinding and mixing organic materials with different compositions, **processing** - composting under controlled conditions and **past-processing** - using compost in growing systems when roots take up nutrients like the intestines in our bodies.

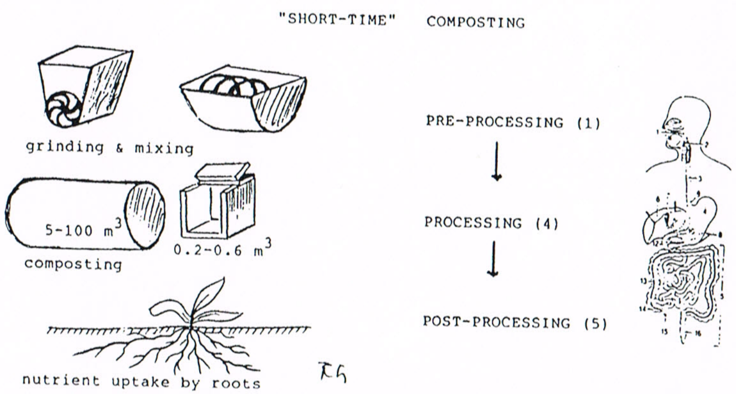

Figure 2. Composting can be compared with human digestion (according to Gotaas, 1956; Brunes, 1988; Georg Blomberg, 1988, personaly communication).

Compost effects on soils

Compost has the ability to condition soils in ways that can directly and indirectly improve plant growth. Proper management of organic wastes on land is essential for maintaining soil productivity. Increasing the amount of organic matter in soil is important for protecting agricultural soils from wind and water erosion, and for preventing nutrient losses through runoff (Parr and Willson, 1980). The beneficial effects of organic matter on the soils physical (structure, aggregate stability, water infiltration, water holding capacity, water content, aeration and permeability, soil aggregation and rooting depth by increased soil crusting and lower bulk density...), chemical (carbon/nitrogen ratio, buffering capacity, nutrient holding capacity, cation exchange capacity, pH...) and biological (microbial activity, enzymatic activity, biological control of plant patogens...) properties are widely known (Gotaas, 1956; Hoitink, 1980; Ljunggren, 1989; Parr and Willson, 1980).

Influence of compost on rhizosphere can result in better root growth. The use of compost in growth media for horticultural plants has to be adapted to different stages of plant development by using different volume ratios for various cultivars in order to improve establishment at different growth stages (Fig. 3).

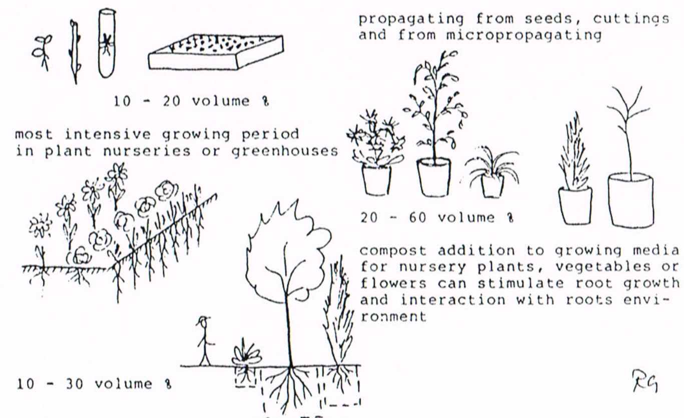

Figure 3. Possible applications of compost to horticultural plants at different stages of plant development (according to: Gajdos, 1989; Hoitink, 1986; Zucconi et al., 1981).

Growth test

The objectives of the experiments were to study the possibility of composting separately collected household wastes to yield better compost quality (Gajdos, 1987). In the experiment with composting sorted (separately collected) and unsorted household wastes the method with forced aeration was used. Figure 4 presents the most important results obtained by bioassay during one month. Notice that different test plants gave different yields. Mixture of 10, 20, 30 and 40% compost was applied. For each test plant the most suitable mixture is presented.

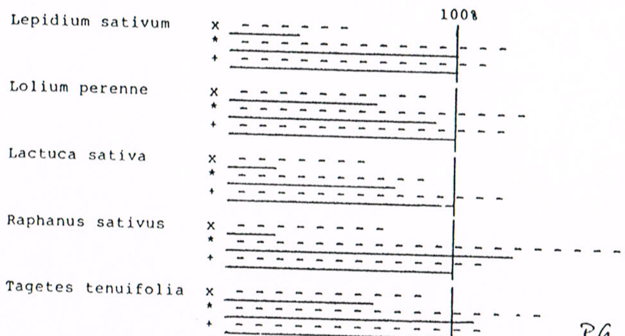

Figure 4. Fresh weight after 4 weeks in growth chamber. Alnarp 1987. (x) compost from unsorted household wastes mixed with peat, (*) compost from separate collected household wastes mixed with peat and (+) the best one out of seven horticultural substrates which gave the highest fresh weight (100%); - - - - with fertigation, ——— without fertigation

Results in figure 4 can be compared with effects of organic amendment described by Avnimelech (1986, cp. fig 1.1. page 5). The study indicades that composting sorted household wastes results in compost which is however still insuitable as part of a growth medium. Analysis showed lower content of heavy metals than in compost from unsorted household wastes. On the other hand analyzed plant nutrients appeared in levels too unbalanced for culturing (Gajdos, 1987). This situation has been caused by incorrect handling of organic wastes composting process. Problems started with the collection of selected household wastes in plastic bags, continued during the time between collection and composting when putrification process started and culminated in the compost when the collected wet material was composted without necessery addition of dry, carbon rich biologicaly degradable material. Composting principles had not been taken into account.

Using recycled materials is one important step in reducing chemicals and fertilizer needs. Household biologically degradable wastes should be collected in two parts: **fresh** (wet, moist) organic wastes and **dry** organic wastes which can be used as bulk material. The fresh part of organic wastes has to be treated as quickly as possible. In fact each family produces only 1 - 5 kg fresh organic matter in week. This rapidly degradable organic material needs special attention. Mixing properly collected and right handled household wastes with garden wastes, stroh, bark or other organic materials rich in carbon, can lead to products suitable for culturing.

Compost quality depends on consistency when separating the material, collecting and, obviously, on composting process. Small mistakes in one of these steps may result in an incomplete product.

Composting test; "short-time" composting and growth test. Four types of composting containers (SF, CH, CDN, S) - developed in different countries - were tested. Mixtures of different garden wastes (grass clippings, weed plants, shredded branches) were composted. In each composting container the same amount of mixture was inserted. Compost samples were analyzed according to modified Spurway method (Månsson, 1989; personal communication) which shows pH, conductivity, NO_3-N, NH_4-N, P, K, Mg, S, Ca, Na, Cl, Mn and B. Compost (20 volume %) was mixed with soil (80 volume %). The used morain soil (upper 10 cm of topsoil) was taken from a field at Alnarp (in the south of Sweden). Seeds of Lactuca sativa, Raphanus sativus and Tagetes tenuifolia were sown.
Table 1 presents composting containers, NH_4-N and NH_3-N content in composts. Figure 5 shows schematic pictures of the main results reccived in growth tests.

Table 1. Changes of nitrogen (mg/l compost) in four different composting containers (SF, CH, CDN, S) (Gajdos, 1989)

Compost age weeks	Composting containers	SF	CH	CDN	S
4	NH_4-N	674	329	236	318
	NO_3-N	39	186	306	111
8	NH_4-N	104	158	104	268
	NO_3-N	274	369	226	219
10	NH_4-N	15	8	25	76
	NO_3-N	240	229	295	263
17	NH_4-N	7	7	5	6
	NO_3-N	157	340	167	369

Decreasing ammonium content during composting process has also been reported by Svensson (1987, tab 2, page 18).

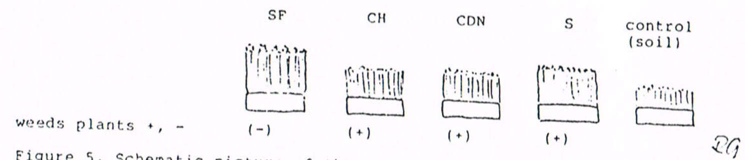

Figure 5. Schematic picture of the growth test with dilution of 20% four-week-old compost in morain soil, expressed in biomass and occurrence of compost borne weed plants (- to +) (Gajdos, 1989)

Note that compost from container SF (insulated box) worked as long term nitrogen fertilizer and that there was no weed seeds surviving the compost process.

During composting can high amounts of nitrogen disappear (Fig 6). It is therefore recommendable to save this nitrogen by blending organic wastes in order to stimulate bacterial nitrogen fixation (Ljunggren, 1989; personal communication).

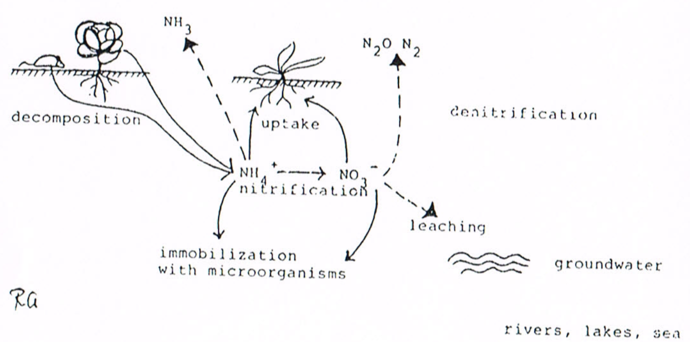

Figure 6. Nitrogen losses during decomposition (according to: Berg, 1986; Ljunggren, 1989; Olsen, 1989).

For a substantial furthering of composting the following aspects have to be emphasized:

It is important to reuse all organic residues from households, industry, agriculture, forestry and so on.

There is a grate need for biological thinking when we use technology.

Proper management retains high nitrogen levels in compost.

The main point is to make **COMPOSTS** of different composition but with one common goal: **SUITABILITY FOR GROWING.**

Literature

Acock M.C. and Overcash J.P. 1983 Effect of growing medium and cultivar on the container cultureof pecan seedlings. HortScience 18, 330-331.

Avnimlech Y. 1986 Organic residues in modern agriculture. In: Y. Chen and Y. Avnimelech (eds.) The Role of Organic Matter in Modern Agriculture, Dordrecht, Boston, Lancacter.

Berg P. 1986 Nitrifier population and nitrification rates in agricultural soils. Institutionen för mikrobiologi, SLU, Rapport 34.

Brunes L. 1988 Angående kompostering av stallgödsel i reaktor system. Statens Lantbrukskemiska Laboratorium, Umeå.

Gajdos R. 1987 Växtodlingsförsök med kompost. In: Reforsk's publikationsserie FoU nr 22, 1987.

Gajdos R. (1989): Test av komposteringsbehållare för fritidsodling (in preparation).

Golueke C.G. 1978 Composting. A study of the process and its principles. Rodale Press, Emmans, Penna.

Gotaas H.B. 1956 Composting. Sanitary Disposal and Reclamation of Organic Wastes. World Health Organisation, Geneva.

Hoitink H.A.J. 1980 Composted bark, A Lightwight Growth Medium with Fungicidal Properties. Plant Disease 64, 142-147.

Ljunggren H. 1988 Mikroorganismerna i komposteringsprocessen. Contribution on the course on "Kompostering - avfall - miljö", Uppsala, 14-15/3 1988.

Olsen S.R. 1986 The role of organic matter and ammonium in producing high corn yields. In: Y. Chen and Y. Avnimelech (eds.) The Role of Organic Matter in Modern Agriculture, Dordrecht, Boston, Lancacter.

Parr J.F. and Willson G.B. 1980 Recycling organic wastes to improve soil productivity. Hort.Sc. 15, 162-166.

Svensson C. 1987 Kommunal avfallskompost och dess användbarhet. SLU inst för markvetenskap, Uppsala.

Zucconi F., Forte M., Monaco M. and de Bertoldi M. 1981 Biological evaluation of compost maturity. BioCycle 22, 27-29.